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DEFENSE SYSTEMS MANAGEMENT SCHOOL

PROGRAM MANAGEMENT COURSE
INDIVIDUAL STUDY PROGRAM

A VIEW OF THE EVOLUTION OF THE
RELIABILITY IMPROVEMENT WARRANTY (RIW)

STUDY PROJECT REPORT
PMC 76-1

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

STUDY TITLE:

A VIEW OF THE EVOLUTION OF THE RELIABILITY IMPROVEMENT WARRANTY (RIW)

STUDY PROJECT GOALS:

- To investigate the development of RIW.
- To review the implementation of RIW.
- To review the Council of Defense and Space Industry Association's (CODSIA) role in RIW.

STUDY REPORT ABSTRACT:

This report tracks the DOD involvement in and development of a category of warranty seeking good product reliability and also reliability growth or growth potential called RIW that has evolved over a number of years from DOD and industry experiences. The report provides a historical trail leading to RIW as used in DOD with primary emphasis on the Air Force's recent experience.

As with philosophies of any nature, there are differing opinions, assessments, and schools of thought on the application, interpretation, structuring, and benefits of RIW.

The report briefly discusses some of the commercial airlines' warranty concepts, Government and industry views or opinions are presented. The report details the CODSIA involvement and role in RIW structuring and usage during the current DOD trial test of the concept.

The DOD test started in 1973. In 1974 it was further definitized and the term RIW and its concepts were presented for the trial use project. However, no specific trial/test parameters have been established. Currently the individual services may apply RIW as they determine within the overall DOD guidelines. Achievement or consummation of the assessment of RIW's merit, benefits, hazards and policies is the task that DOD is at grips with now.

Alternatives to the current DOD RIW test approach are presented; (a) formalize the test, (b) implement the concept based on existing data, or (c) terminate the test. It is the author's recommendation that: (a) the test be formalized for a period of 1 one more year or less; (b) the current RIW programs be evaluated in depth and new programs be added very selectively (if not at all); (c) DOD, CODSIA and ARINC coordinate or compromise on implementation details and contractual provisions based on the findings of the one year test (if RIW is approved as a concept for continued use).

KEY WORDS: RELIABILITY, WARRANTY, RIW

NAME, RANK, SERVICE	CLASS	DATE
Allan E. Schmidt, Major, USAF	PMC 76-1	May 1976

SCHMIDT

KEY WORDS

MATERIEL ACQUISITION RELIABILITY LIFE CYCLE COST RIW
MTBF

A VIEW OF THE EVOLUTION OF THE RELIABILITY IMPROVEMENT WARRANTY

Study Project Report

Individual Study Program

Defense Systems Management School

Program Management Course

Class 76-1

by

Allan Edward Schmidt
Major USAF

May 1976

Study Project Advisor
LTC Bernard Demers

EXECUTIVE SUMMARY

This report tracks the Department of Defense's involvement in and development of a category of warranty seeking good product reliability and also reliability growth or growth potential called Reliability Improvement Warranty (RIW). It has evolved over a number of years from DOD and industry experiences. The report provides a historical trail leading to RIW as used in DOD with primary emphasis on the Air Force's recent experience.

As with philosophies of any nature, there are differing opinions, assessments, and schools of thought on the application, interpretation, structuring, and benefits of RIW. Each of these differences can bring actual or plant the seed for potential conflicts in RIW usage in the areas of (a) concept acceptance, and (b) the motivations of both Government and contractor personnel to fulfill their prospective program/contract obligations.

The literature indicates RIW has either proved its merit or has the potential for benefits. This is of course subject to interpretation or debate. Of prime importance to any RIW payoffs would be the proper application and/or implementation in each usage. Achievement or consummation of the assessment of its merit, benefits, hazards and policies is the task that DOD is at grips with now.

The DOD test started in August 1973 as the Trial Use of Warranties in the Acquisition of Electronic Subsystems. In August 1974 the project was further definitized and the term RIW and its concepts were presented for the trial use project. However, no specific trial/test parameters have been

established. Currently the individual services may apply RIW as they determine within the overall DOD guidelines.

There are three current opinion factions, namely (a) DOD - more trial tests, (b) CODSIA - a "temporary moratorium" and (c) ARINC - implement now where applicable. There are many points to evaluate in determining the best or optimum DOD decision. Aside from the obvious considerations as to the cost effectiveness of any type RIW or warranty applied in a particular case, are other broader conceptual implications both on the particular system and/or the DOD acquisition business in general.

Since the ultimate fate or future of RIW should result from an unbiased trial evaluation, it is my contention there should be a structured test of the concept similar to the four step source selection procedure being tested through DOD Directive 4105.62.

Alternatives to the current DOD RIW test approach are (a) formalize the test, (b) implement the concept based on existing data or (c) terminate the test. It is my recommendation that (a) the test be formalized for a period of one more year or less; (b) the current RIW programs be evaluated in depth and new programs be added very selectively (if at all); (c) DOD, CODSIA and ARINC coordinate or compromise on implementation details and contractual provisions based on the findings of the one year test (if RIW is approved as a concept for continued use).

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SECTION I

INTRODUCTION

A. Project Scope

This report tracks the Department of Defense's involvement in and development of a category of warranty seeking good product reliability and also reliability growth or growth potential. This current warranty philosophy/policy is called Reliability Improvement Warranty (RIW). It has evolved over a number of years from DOD and industry experiences.

As with philosophies of any nature, there are differing opinions, assessments, and schools of thought on the application, interpretation, structuring, and benefits of RIW. Each of these differences can bring actual or plant the seed for potential conflicts in RIW usage in the areas of (a) concept acceptance, and (b) the motivations of both Government and contractor personnel to fulfill their prospective program/contract obligations.

This research report does not discuss other warranty categories such as supply, correction of deficiencies, service, construction, or implied. It also does not deal with the contract award considerations in evaluating the cost effectiveness of an RIW proposal versus other possible warranty or support alternatives. It highlights only aspects of the RIW concept per se.

It also provides a historical trail leading to RIW as used in DOD with emphasis on the Air Force's involvement. Some discussion will be given to

the arguments as to the proper balance between contractor risk and incentives. Mention will be made of the commercial airlines' warranty concepts. Industry views or individual opinions are also presented that reflect the necessity for (a) the RIW concept to be fully understood, and (b) industry/government agreement be reached on implementation details.

From the fact developed during the research, recommendations for RIW evaluation and implementation will be presented.

B. Definitions

A few definitions are necessary to baseline discussions in this report.

Warranty - The Armed Services Procurement Regulation (ASPR) 1-324.1 discusses a warranty as . . . . .

> A warranty is a promise or affirmation given by a seller to a purchaser regarding the nature, usefulness, or condition of the supplies or performance of services to be furnished. The principal purposes of a warranty in a Government contract are to delineate the rights and obligations of the contractor and the Government for defective items and services and to foster quality performance. Generally, warranties survive acceptance of the contract items for a stated period of time or use, or until the occurrence of a specified event, notwithstanding other contractual provisions pertaining to acceptance by the Government.

Reliability - The probability that an item will perform its intended function for a specified interval under stated conditions.

RIW - An RIW is defined (16:4)[1] as a provision in either a fixed price acquisition, or fixed price equipment overhaul contract in which:

[1]This notation will be used throughout the report for major references. The first number is the source in the bibliography. If the source is a page-numbered document, the second number is the page number.

a) the contractor is provided a monetary incentive, throughout the warranty period, to improve the item's production design and engineering so as to enhance its field/operational reliability and maintainability through no cost to the Government changes; and

b) the contractor agrees that during a specified or measured period of use, he will repair or replace (within a specified turnaround time) all failed equipment (subject to any specified exclusions).

Failure-Free Warranty - This was basically a maintenance contract for a certain period of time after equipment delivery. All failures were warranted (except specific exclusions). It also provided financial incentives for improved reliability by reducing returns for repair (11:39). FFW has been superceded by RIW.

Mean Time Between Failures (MTBF) - It is determined by dividing the total number of failures of a component during a specified interval into some given measure of the component's life (time, cycles, etc.). It is an average of a population.

C. Overview of Reliability Importance

It is usually accepted that as a piece of equipment matures, there is reliability increase over its initial design. Figure 1 shows the MTBF curves of two pieces of equipment in a recent program (3:5). From these observations, it could be argued that long-term warranty incentives during the inherent growth period could increase the growth rate and possibly minimize the costs to achieve it (3:4).

Figure 2 is an actual case that is typical of how life cycle costs (LCC) decrease as MTBF increases (3:5). In this case, later excessive reliability development emphasis on higher MTBF caused increase in LCC (3:4).

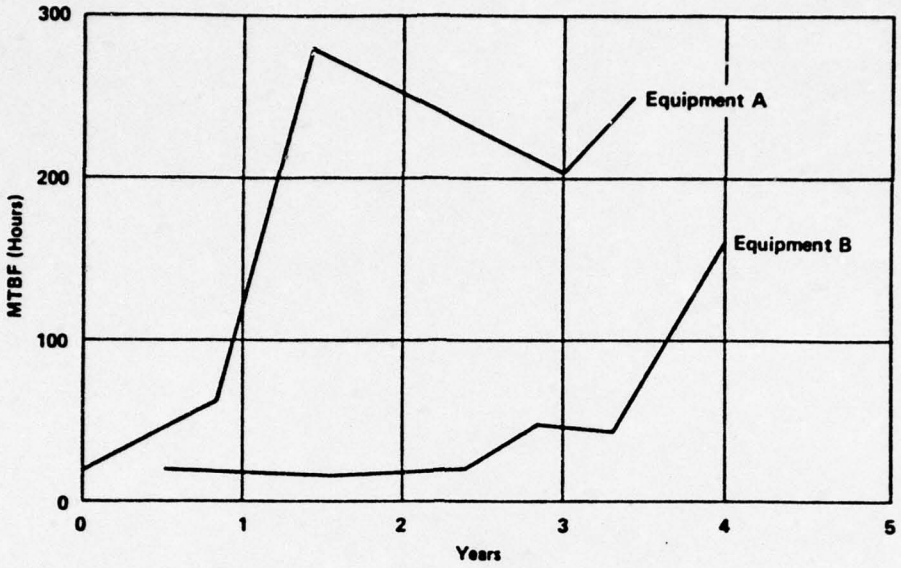

FIGURE 1

RELIABILITY GROWTH

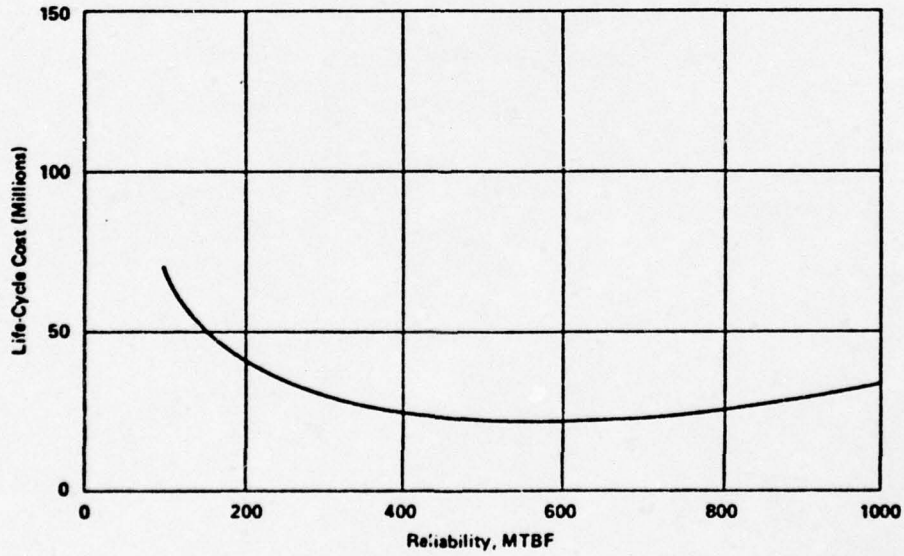

FIGURE 2

LIFE-CYCLE COST VERSUS RELIABILITY

Figure 3 shows the probable relationship (solid line) of MTBF to contractor profitability with the ideal relationship (dotted line) superimposed where the "rewards can be paid for by reduced life-cycle cost of the supported equipment" (3:5). The exact shape and relationship of these curves is not as important as the concept of a profit incentive for higher MTBF.

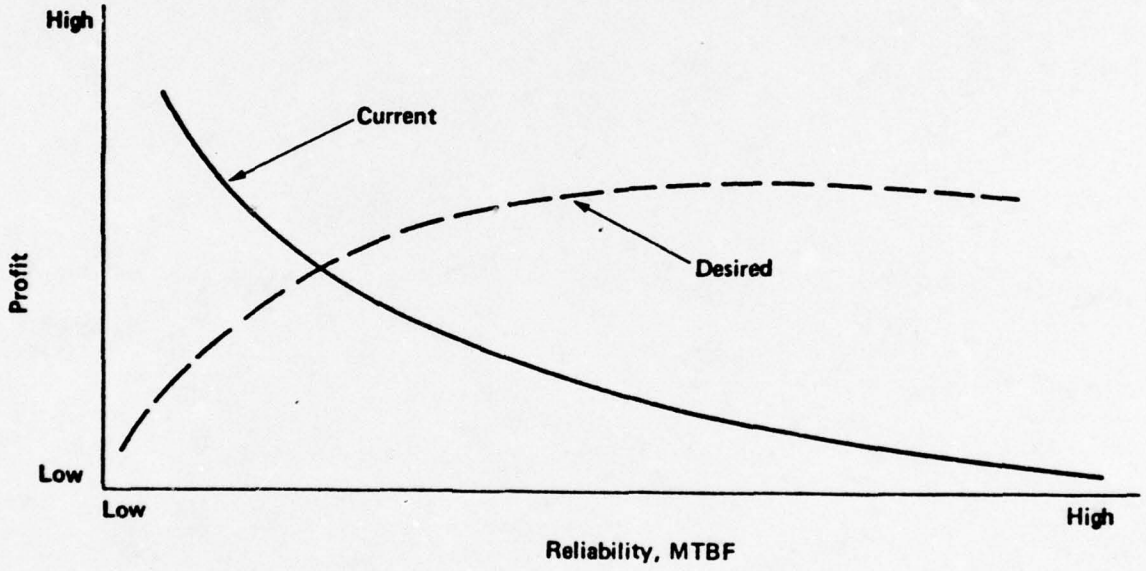

FIGURE 3
PROFIT VERSUS RELIABILITY

From the above observations there is an apparent basis that a long term warranty and resultant contractor commitment and dedication could be beneficial to both parties.

SECTION II

HISTORICAL BACKGROUND

A. Reliability versus Quality

For a number of years, the terms "quality assurance" and "reliability" were considered as synonymous. For a time there may have been validity to that relationship, especially prior to the many technical breakthroughs and expanded complex operation settings of equipment subsequent to World War II. A concise summary of the terminology differences is expressed in a paper (17:371) presented to the 1976 Annual Reliability and Maintainability Symposium -

> The quality function establishes that each equipment conforms to a blueprint and functionally operates in accordance with equipment final test procedures at a single point in time in room ambient conditions. The reliability function assesses the equipment relative to how the equipment will perform over a long duration of time in extreme environmental conditions. Because of this difference, each process and manufacturing technique must be evaluated in view of reliability requirements in addition to quality requirements.

B. Reliability Breaks Out (1:10)

During 1959, the House Appropriations Committee (HAC) was concerned about the reliability of ballistic missiles and established a group of industry and National Bureau of Standards experts to review the services' ballistic missile programs. The report, entitled "Reliability Efforts in

Ballistic Missile Programs", was published in the Hearings for Department of Appropriations for 1960 (Part I--Policy Statements).

In March 1960, the Secretary of Defense and key ODDR&E officials were given a briefing that included:

1- Nature of Reliability Problems
2- OSD Policy Responsibility in Reliability
3- Military Specifications and Reliability
4- Technical Requirements and Incentives for Reliability
5- Quality Control and Reliability
6- Summary of Recommendations Applicable to ASD/I&L
7- Recommendations of HAC on Missile Reliability

With the recognition of reliability considerations and increased DOD reliability emphasis, the Inspection Division within the office of the Assistant Secretary of Defense for Installations and Logistics (ASD/I&L) was thus retitled in 1960 to Quality and Reliability Assurance.

C. Development of Reliability Techniques

1. Failure Free Warrranty (FFW) Inception

Any discussion of reliability comes around to the historical actions of the mid-1960's that started to reduce the desires and theories into actuality through contracts.

In the early 1960's, a joint study undertaken by Air Force Logistics and Systems Commands in a concept called the Real/Ultimate Cost of procurement was expanded to include a product-life warranty system in the life cycle cost area. As a result of this effort, a hardware candidate was identified through a proposal from the Instrument Divison of Lear Siegler, Inc., in 1964. The program involved a planned multi-year procurement in

1965 of several thousand MD-1 vertical gyroscopes. Lear Siegler offered to participate on a failure free warranty basis providing for repair or replacement, at their option, of any failed unit within five years or 5000 operating hours, whichever came sooner (12:24). Although the Lear Siegler proposal was not accepted, efforts continued to lay the groundwork for the broader type warranty concept.

In 1967, the Navy awarded Lear Siegler the first FFW type contract for the overhaul and repair of 800 2171P displacement gyroscopes. It culminated approximately seven years of joint efforts to develop a new procurement method to result in lower operating costs (25:4). Of importance for later discussions in this report were the criteria by which the gyro was selected as a viable FFW candidate.

High volume
High value
High usage
Long term
Sealed unit
Data history

Using this data, an MTBF was developed that made the baseline for FFW contract cost, negotiations, and product reliability improvements (25:4).

It should not be assumed that this initial FFW contract came about easily. Several years of planning and talks were involved. DOD contracting and funding policies required coordinations and/or revisions. Even when the contract was entered into, there were apparently some reservations present as evidenced by a Navy official's acknowledgment that he originally opposed the concept as it was first suggested in 1966-67 by Lear Siegler. However, several years later he was "wildly enthusiastic" about the idea (1970), and wished that more Navy suppliers would consider it (13:57).

Since the Lear Siegler program was the first of its type, it is interesting to give a report card on the end product results. Figure 4 (11:39) shows the initial planned target MTBF increase from the 400 hour baseline to 520 hours in December 1972. It also reflects the progression of the actually achieved MTBF of 531 hours in January 1973. This improvement also resulted in a 40% reduction in field maintenance costs per operating hour.

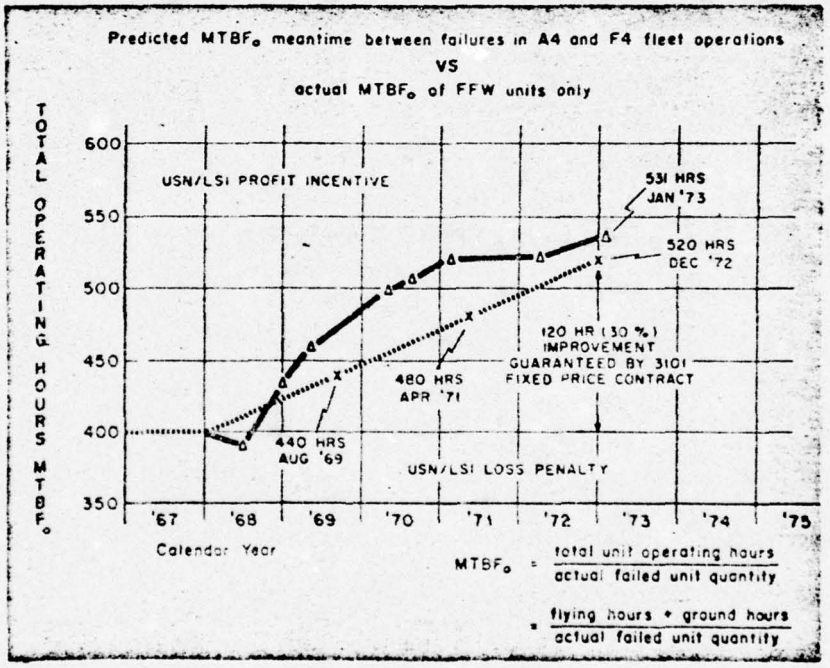

FIGURE 4

That contract undoubtedly reflects well upon the efforts of all parties to make the concept work. Realistically, I believe Lear Siegler probably devoted extra or inordinate efforts toward success since they had been an

active proponent of the concept. Future such warranty arrangements would have been jeopardized if the first program did not get off to a good start. Although there was minimal data available to fully evaluate how the Lear Siegler FFW contract would turn out, another contract was competitively awarded by the Air Force to Lear Siegler in 1969. It was for production of the Mini-PAR-2 attitude and heading reference system for the F-111 aircraft (13:57).

Increased warranty interest was expressed by the Air Force's Director of Procurement Policy in a 1969 speech -

> Now let's go to warranties. I am going to start with product warranties. Let me tell you, gentlemen, there's a warranty in your future, and it can take many forms . . . . . There will be warranties on quality and reliability features as well. We are going to say, "Put your reliability on the line and put your dollars and your reputation where your mouth is!" There are going to be more and more warranties as time goes on. Industry must stand behind its products and warranties are one way of getting that contractor support. We will get his attention as well (14:24).

These were strong expressions, however the message was clear that the Air Force planned a pursuit of reliability warranties.

Over the next several years as concept data was gathered, a few other contracts with FFW provisions were awarded by the Navy and Air Force. It is interesting to note that several of these systems were already in use with field experience, thus the government and contractor risks with the concept were minimized. It was not until 1975 that the Army awarded its first contract for a similar but slightly different concept of RIW (4:122).

FFW was pursued and used in an attempt to solve reliability and

performance problems in field use. The existing procurement practices did not fully motivate the contractor to maximize the actual performance of the end item. Basically, after the items were accepted, the contractor's interest could diminish. His desire to maintain a good reputation to assist him in follow-on procurements would (or should) be present, however, in a practical sense, his contractual ties with the end item were (are) severed after delivery/acceptance. FFW provided contractual long-term performance warranty and gave the contractor profit incentive through the arrangement's fixed price aspect, i.e., up to a point, the more the MTBF improved, the less were the contractor's maintenance costs with the Delta $ his additional profit.

The warranty was not limited to failures due to manufacturing or quality defects, but included (with certain exceptions) any failure during operation. Thus the contractor is guaranteeing that the item's population will operate at a certain MTBF. In addition, the FFW concept provided for no-cost contractor generated Engineering Change Proposals (ECPs) to correct deficiencies or improve reliability over the minimum. The no-cost ECP incentive to him lay within the potential reduced contractor's maintenance costs because of a lower repair return rate. It is logical, however, that there would be a crossover breakeven point where a projected ECP cost would not be economical to implement either due to its basic cost or the time remaining on the contract over which to amortize it.

There would also be another incentive even though it cannot be quantified. Through a long-term warranty, the contractor and the government are tied together "for better or worse". The contractor will be gaining insight into his product and the military systems. He is also

bound to become "smarter" in many other ways that should enhance his position in the market and on future procurements (military or commercial). The long-term relationship is a two-way street, however, and can work against a contractor if his product is the source of operation problems, the outcome or correction of which could affect the company's ability to compete successfully for subsequent buys.

In addition to the military's warranty history, discussion of a commercial industry's development and use is appropriate at this point.

2. Airline Experience/Methodology

Many times the Department of Defense aircraft operations are compared (or attempted to be) to the airline industry and/or the commercial sector that supports them. These comparisons cover the full range of subjects from initial system or subsystem acquisitions to day-to-day operating and maintenance methods. For this reason, mention of the airline approach to equipment warranties is appropriate. This becomes even more significant when the reader is aware of the actual influence the extensive airline total industry plays in the development of military aircraft equipment through development and standardization practices. An example of this is the Airlines Electronic Engineering Committee made up of representatives from 14 United States airlines, six European, one Canadian, and one general aviation. The committee has several advisory members including four from ARINC Research Corporation. It is chaired by one of the ARINC representatives. Through this group, ARINC characteristics are developed for electronic items. They are form, fit, and function type

standards to which designers and suppliers provide equipment that is interchangeable between manufacturers while in use. The interchangeability benefit is that it enhances the competitive atmosphere since a poor performing item can be easily replaced by a competitor's item.

The Air Transport Association of America publishes the "World Airline's Supplier's Guide" that listed four basic industry warranty types (3:13) -

1. Standard Warranty (failure-free). Applies to avionics as well as other items and, in effect, warrants that all items will be free from defects in material, workmanship, and design; conforms to specifications; and suitable for the intended use. Extends for specified number of operating hours or calendar time or a combination of both. Vendor normally assumes responsibility for labor and material costs necessary to correct any failures occurring during the warranty period. Standard warranties, typically, have been for a one-year period, but has been extended up to three years for the newer aircraft systems.

2. Ultimate Life Warranty. Applies to major structural components. Warrants that such components will be free from defects for a stated number of flying hours. Protection beyond the normal failure-free warranty period is provided. Claims are generally adjusted on a pro-rated basis consistent with the amount of usage achieved.

3. Reliability Guarantee. Vendor required to have product achieve stated mean time between failures. Such agreements generally recognize that the initial deployment will experience infant mortality and thus require that the MTBF be demonstrated after some initial period of operational time. Typically runs until the warranted MTBF has been demonstrated for a stated number of consecutive months. If at any time the vendor's products fail to meet the specified MTBF, the vendor is required (1) to supply additional spare units to support the airline's operations until the required MTBF is achieved and (2) to provide technical assistance and/or modification kits and labor to achieve the warranted MTBF.

4. Maximum Parts Cost Guarantee. Agreements are established with the airline on a maximum materials cost per a measure of usage for maintaining, modifying, repairing, and overhauling selected items. Typical applications include

aircraft tires and brakes. Reimbursement is made either on a 100-percent or a pro-rated basis of the difference between the actual cost and the specified guaranteed value. Guarantees, typically, are for a period of ten years, commencing with the product's first use.

The procurement atmosphere of industry versus military has many differences. Some are brought about by technological or operational requirements, others by Public Law constraint (Armed Services Procurement Regulations), and some probably by a slowness to change old schools of thought or adapt less rigid regulations. In fairness to the military procurement process, the spending of public money will always place them in the middle between companies or legislators who are pleased with a particular action and those who are not. Because of this narrow path, regulations have developed that do not provide the contracting flexibility apparent in commercial dealings.

Notwithstanding the differences in basic policies, Figure 5 shows a comparison of avionics procurement practices as researched by ARINC (3:10).

The ARINC research also provided comparisons of various types of avionics equipment reliabilities as shown in Figure 6 (3:12). They point out there are differences in operating and maintenance between airlines and also in types of aircraft. There are obvious extreme operating differences when compared to the military's usage in all climates, altitudes, and maneuverability conditions. ARINC's point was that "while it is not possible to quantify the degree to which these factors affect observed MTBF, the extensive airline use of warranty provisions in their avionics procurement contracts would certainly exert a positive influence

on initial reliability achievements and on reliability growth". They further stated that "there is no question that the airline community has had a very satisfactory experience and intends to increase its reliance on warranty for more inclusive reliability and cost control".

A COMPARISON OF
AVIONICS PROCUREMENT BY AIRLINES AND MILITARY SERVICES

Procurement Element	Airlines	Military Services
Technological Environment	Current technology satisfactory	Need to push the state-of-the-art in some areas
Specification Development	Done in open forum by AEEC, a group of users and manufacturers	More one-sided -- limited give-and-take sessions
Specification Format	Form-Fit-Function -- other characteristics not specified	Rigorous requirements on all characteristics (also, assurance procedures)
Specification Use	Individual users may or may not employ specification (voluntary)	Must be employed (mandatory)
Testing	Only through Tech. Standard Orders (TSO)	Rigorous acceptance tests
Contracts	Simple -- minimal paper work	Complex -- mountains of paper work
Warranties	Widely used	Seldom used
Competition	Exists at all times	Essentially ceases to exist after contract award
Information Feedback	Rapid, credible -- affects subsequent procurements	Not credible -- seldom a factor in reprocurement
Logistics	Standardization only to Form-Fit-Function	Standardization within black boxes -- minimizes number of types of spare parts

FIGURE 5

SOME COMPARISONS BETWEEN AIRLINE AND MILITARY AVIONICS RELIABILITY

Equipment	Source (M = Military)	Operating (O) or Flying (F) Hours	Number of Removals	Number of Failures	MTBR	MTBF
Weather Radar						
RDR-1F	Airline A	438,480 (O)	1,307	390	335	1,124
RDR-1F	Airline C	NA (F)	NA	NA	555	1,157
AVQ-30	Airline B	186,810 (O)	561	NA	333	666*
AN/APS-115	P3C (M)	19,450 (O)	295	149	66	130
Inertial Navigation						
Carousel	Airline B	326,500 (O)	925	NA	353	706*
LTN-51	Airline Composite	360,720 (O)	NA	361	450*	999
AN-ASN-84	P3C (M)	35,900 (O)	442	186	81	192
LORAN (A & C)						
345 & 700 (A)	Airline B	182,460 (O)	568	NA	322	644*
AN/APN-151 (C)	RC-135 (M)	9,600 (O)	NA	94	51*	102
AN/APN-157 (C)	C-141/HC-130H (M)	164,400 (O)	NA	3,823	22*	43
HF Communications						
618 T-2	Airline B	228,400 (O)	555	NA	412	824*
ARC-142	P3C (M)	28,520 (O)	608	160	47	178
UHF/VHF Communications						
RTA-41A	Airline B	326,530 (O)	591	NA	552	1,104*
ARC-143	P3C	37,430 (O)	468	115	80	325
Automatic Direction Finder (Receiver)						
DFA-70	Airline Composite	647,270 (F)	643	359	1,006	1,802
DFA-70	RC-135/WC-135 (M)	30,150 (F)	NA	141	107*	214
DFA-73	Airline Composite	38,500 (F)	41	26	939	1,480
DFA-73	C-141/HC-130 (M)	1,100,000 (F)	NA	1,240	444*	887
Marker Beacon (Receiver)						
51Z-4	Airline Composite	570,300 (F)	180	114	3,168	5,000
51Z-4	C-141 (M)	506,670 (F)	NA	184	1,376*	2,753
VOR Localizer (Receiver)						
WIL 806A	Airline Composite	NA (F)	NA	NA	570	1,000
WIL 806A	C-141 (M)	506,670 (F)	NA	1,654	153*	306

*Data not available. For gross comparison, estimate based on MTBF = 2 × MTBR.

FIGURE 6

This type of commercial influence, along with the military's limited experience data, led to DOD's next warranty phase.

3. DOD Trial Use of Warranties

The concept work that had been going on for several years received a major boost when ASD/I&L and ODDR&E issued a joint memorandum, 17 August 1973, to the Army, Navy, and Air Force Secretaries; Subject: Trial Use of Warranties in the Acquisition Process of Electronic Subsystems (19:1). It set out some basic groundrules and actions to occur. The memo's first paragraph effectively summarized the task.

> In industry, extensive use is made of warranties, thereby establishing the manufacturer's responsibility to provide a usable and available product during a period of time. To achieve this economically, many techniques have been employed by the supplier (i.e., more reliable products are designed; designs are improved to increase reliability during the initial operation phase; economic maintenance and repair procedures are developed). Accordingly, it is requested that a trial application of warranties be utilized in the acquisition and initial operational support of a number of Electronic Subsystems to help determine the scope and benefit warranties may have for the DOD, as well as effective management approaches. The warranty approach envisaged is one in which the supplier agrees to repair or replace malfunctioning or defective items of equipment during a specified period of time.

Subsequent to the above memo, two happenings are noted. First, an OSD committee was formed, and later the term FFW was changed to RIW (Reliability Improvement Warranty). Changing the terminology had no specific consequences, however, it did better describe the current state-of-the-art of FFW. Because the FFW involved an extended period of time with built-in contractor incentives through reliability improvement provisions (maintenance and ECPs), such a change was suggested in the 1973 ARINC technical report. Their term was "reliability warranty," which they said did not describe the specific

warranty provisions, but did highlight the major equipment characteristic of interest (3:6).

Within the next year the Institute of Defense Analysis completed an "Electronics-X" study to DDR&E (10:A-31). The joint government and industry report contained over 100 recommendations for "streamlining DOD electronics procurement." The emphasis on electronics was due to the fact that "DOD spends a fifth of its budget on electronics or $15.3 billion annually." One of the major recommendations was -

> Contractors should be motivated to provide greater reliability by requiring long-term warranties on defense products. Experience suggests that warranties motivate contractors to use design modifications to increase reliability. Such warranties are also a competitive alternative to military repair of electronic equipment (10:A-32).

The study thus gave impetus and/or support to the next DOD warranty phase highlighting electronics equipment.

The next major concept milestone occurred with the release of a joint ASD/I&L and ODDR&E memo to the Assistant Service Secretaries for I&L and R&D on 14 August 1974; Subject: Trial Use of Reliability Improvement Warranties in the Acquisition Process of Electronic Systems/Equipment (20:1). The memo accomplished or set out three major items:

a) The term RIW was to be used in place of FFW.

b) As a result of the OSD committee efforts, an RIW Guidelines document was prepared and enclosed.

c) Immediate trial RIW use was authorized for service selected Electronic Systems/Equipment programs.

The Guidelines document set the groundrules and parameters for the services to use in determining RIW candidates and in evaluating the approach's potential cost effectiveness. It also contained funding and administrative guidance. The major content features are outlined here.

1- Definition and Scope
2- RIW Application Criteria
3- Funding
4- Essential Elements in RIW Clause
5- Statement of Contract Warranty
6- Contractor Obligation
7- Government Obligation
8- Data Requirements
9- Determination of Cost Effectiveness of RIW use
10- Evaluation Approach
11- Ramifications
12- Potential Government/Contractor Benefits

The guidelines' Application Criteria portion has caused the most controversy and is a major reason why RIW is a topic worthy of investigation. Due to their significance and relationship to subsequent aspects of this report, the specific original criteria language follows (16:5).

a) A warranty can be obtained at a price commensurate with the contemplated value of the warranty work to be accomplished.

b) Moderate to high initial support costs are involved.

c) The equipment is readily transportable to permit return to the vendor's plant or, alternatively, the equipment is one for which a contractor can provide field service.

d) The equipment is generally self-contained, is generally immune from failures induced by outside units, and has readily identifiable failure characteristics.

e) The equipment application in terms of expected operating time and the use environment are known.

f) The equipment is susceptible to being contracted for on a fixed price basis.

g) The contract can be structured to provide a warranty period of several years. This should allow the contractor sufficient time to identify and analyze failures in order to permit reliability and maintainability improvements.

h) The equipment has a potential for both reliability growth and reduction in repair costs.

i) Potential contractors indicate a cooperative attitude toward acceptance of an RIW provision and evaluation of its effectiveness.

j) A sufficient quantity of the equipment is to be procured in order to make the RIW cost effective.

k) The equipment is of a configuration that discourages unauthorized field repair, preferably sealed and capable of containing an Elapsed Time Indicator (ETI) or some other means of usage control.

l) There is a reasonable degree of assurance that there will be a high utilization of the equipment.

m) The equipment is one that permits the contractor to effect no-cost ECPs subsequent to the Government's approval.

n) Failure data and the intended operational use data can be furnished the contractor for the proposed contractual period and updated periodically during the term of the contract.

It was noted that the equipment need not meet all the criteria shown above in order to apply an RIW.

4. Air Force RIW Implementation

The Air Force played a major role in the development of the DOD RIW Guidelines document released with the 14 August 1974 ASD/I&L and ODDR&E memorandum previously discussed. Because of this involvement, the Air Force was able to release their implementing guidelines prior to the DOD

official position. The HQ USAF Directorate of Procurement Policy (DCS/LGP) was the focal point and their document was titled "Interim Reliability Improvement Warranty (RIW) Guidelines" dated 24 July 1974 (23:1). The unnumbered publication contained almost verbatim the DOD words. It expanded on several areas such as philosophy, cost and usage effectiveness determination, administration concepts, and potential data reports.

With this direction, two major programs became candidates for RIW utilization. They were the:

a) AN/ARN-118 airborne tacan, and

b) C-141 (C/KC-135) inertial navigation system (INS) modification.

SECTION III

CURRENT SITUATION

A. Recent Awards

The Air Force's first RIW type contract was awarded to Collins Radio by Air Force Systems Command's Electronic Systems Division in July 1975 for the AN/ARN-118 equipment. This culminated approximately three years of program efforts. The five-year RIW features include a guaranteed minimum MTBF achievement of 500 hours 22-33 months after award, and progressively increasing to 800 hours 46-69 months after award (18:55). Performance below the stated MTBF results in recomputation of the spares requirements with Collins having to provide the additional units and correct the deficiency at no cost to the government. Collins provides all maintenance during the period. It is noted that this is a development type program.

The Air Force's second major award followed shortly thereafter in November 1975. Air Force Logistics Command's (AFLC) Warner Robins Air Logistics Center awarded Delco Electronics Division of General Motors the contract to produce inertial navigation systems for the C-141 aircraft with options for the C/KC-135's. The RIW concept allowed the offerors to propose an MTBF higher than the minimum of 750 hours. Delco proposed 1128 hours. The proposed MTBF was then the basis for spares computations. Delco will provide maintenance for four years from initial deliveries. MTBF computations will be done quarterly with Delco providing any additional spares and corrections at no cost to the government. The items are basically ARINC 561 commercially produced by Delco with extensive airline use.

Each of the above programs is in the magnitude of $100 million.

The General Dynamics F-16 program is "potentially the most significant program under consideration for RIW type maintenance" (18:55). Decisions will be made by AFLC during 1976 whether any of up to 13 avionic subsystems should go under RIW.

B. CODSIA Complaint

1. Background

The Council of Defense and Space Industry Associations (CODSIA) is a consortium of industry associations formed in 1964. The members are the major associations who have common interests in defense and space programs and policies.

CODSIA Membership

NSIA	National Security Industrial Association
AIA	Aerospace Industries Association
EIA	Electronic Industries Association
NASSA	National Aerospace Services Association
MVMA	Motor Vehicles Manufacturers Association
SCA	Shipbuilders Council of America
WEMA	Western Electronics Manufacturers Association

Each of the above organizations is individually a strong voice in government business. As a conglomerate, their collective voice is even more significant.

In response to a US Army Procurement Research Office study on warranties, CODSIA forwarded their detailed 2 July 1975 reply. The major thrust was to express concern over many aspects of RIW philosophy and implementation. On 18 July 1975, they also sent a copy of the same response to the Acting Assistant Secretary of Defense and the Director of Defense Research and Engineering I&L requesting DOD level review of RIW policy (5:1). On 12 August 1975 a joint ASD/I&L and ODDR&E reply acknowledged the correspondence and indicated the existence of a Tri-Service working group chaired by a representative of ASD/I&L. They would consider all aspects of RIW with emphasis on the CODSIA concerns.

2. Complaint Summaries (5:1-14)

a) Opposed to defense warranties, commercial warranties impose only limited financial risk, spread over a large production base. They normally exclude implied warranties and contain disclaimers against consequential damages. The related cost contingency can normally be reasonably predicted.

b) The Government's attitude is that increased reliability is solely within a contractor's control and that they do not have enough motivation to build with necessary reliability. The RIW provisions do not recognize the other technical factors that bear on reliability growth.

c) Concept of RIW goes much beyond current ASPR warranty concepts.

d) The DOD approach may be more severe than the practices of commercial airlines.

e) CODSIA sees as a "serious and basic flaw" the idea of RIW on a first production basis for equipment with any significant technical complexity. This situation makes reasonably accurate warranty cost estimating impossible.

f) A proposed alternate approach to a firm fixed price contract would be a modified cost-plus-fixed-fee arrangement. The fixed fee would be subject to proportional reduction as costs are incurred.

g) CODSIA expressed "deep concern" over their observations that field levels will not attempt to make the concept and policies "rational and workable" and that there will be "deviations and additions".

h) The failure exclusions seem much too limited.

i) Turn around times as short as 15-20 days are not realistic for a "complex electronic black box."

j) Having to repair all failures (over the exclusions) "imposes a severe penalty upon a contractor."

k) It seems very unreasonable to require the contractor to bear the return costs of items that test good.

l) The cost of furnishing of no-cost retrofit kits could offset any contractor savings through reliability improvements.

m) A provision to adjust contract prices based on utilization rate changes has a negative impact on the motivation to gain repair cost savings through no-cost ECP's.

n) "Probably one of the most difficult and self-defeating elements of a reliability improvement program is the requirement to guarantee an initial MTBF for a newly designed unit; establish a specified rate of growth from unknown performance; and then superimpose a monetary penalty should the demonstrated MTBF fail to reach the original prediction." This "destroys the incentive portion of a contract."

The basis and interpretation of these comments were of course open for discussion item by item and program by program. No attempt is made here to evaluate the merits of each comment. The major points of the CODSIA letter were that (a) RIW should be used judiciously and primarily

on equipment with sufficient experience data, and (b) that there be a balance of risk and incentives.

C. Revised DOD Guidelines

CODSIA made their point known quickly and at a level to insure a policy review. As a result, ASD/I&L issued a 16 September 1975 memorandum to the Assistant Service Secretaries for R&D and I&L; subject: RIW Guidelines (21:1).

Its purpose was to clarify and expand on the guidelines and reiterate the industry concerns over applications that might "pose undue risk on contractors." Emphasis was given to the main RIW purpose of incentivizing contractors to design and produce reliable equipment and that unreasonable contract terms and contractor risk would be counterproductive.

Of major significance in the memo was the recognition that contract incentive provisions other than fixed price might, in certain situations, be appropriate, i.e., if the particular RIW application "would result in undue risk." In this area the memo mentioned that the subject of RIW contract incentive techniques would be reviewed by a "recently established Tri-Service Reliability and Support Incentives Group."

The memo cited two major RIW application criteria -

a) field reliability, equipment support costs and potential for reliability growth will be reasonably predictable at the time the fixed price offer is made, and

b) RIW terms must be tailored so that industry and government rewards and risks are acceptable.

The memo went on to provide several paragraphs to highlight the philosophy and/or thought process inherent with each of the two criteria. It cited the need for the proper balance of risk to both parties. That RIW can be used for new technology items with no field experience. That there be adequate development and testing time prior to a fixed price offer. That offers be obtained as late as possible to gain benefits of test data. That the stringency of terms and conditions be tailored based on the uncertainties, however not to an extent whereby "the RIW objective of improved field reliability and reduced support costs are no longer incentivized."

The above criteria discussions present very real dilemmas.

a) Adequate development and testing with offers as late as possible yet commensurate with program schedule requirements.

b) The balance of risk (and penalties) and rewards to both parties.

c) Tailored terms based upon uncertainties, but yet maintain the program's RIW objective.

To equate and balance all of this is a significant problem. Uncertainties and contingencies bring an increased price tag. Even if the price still shows the RIW as cost effective, the risk to the program may still be there (schedule, performance and/or cost).

Even after experience projection data is obtained, prior to offers, there may be an element of uncertainty for new or significantly modified items posing the future possibility of impossibility of performance especially under a fixed price arrangement.

The dilemma is how do both parties get the best (or equal share) of both worlds and maintain an amicable program relationship?

D. CODSIA Rebuttal

CODSIA met with DOD representatives in December 1975 to further discuss issues. CODSIA then summarized their feelings in a lengthy 30 December 1975 letter to the chairman of the Tri-Service group in ASD/I&L (6:1). They stated their backing of the DOD desire to "reduce support costs and improve field reliability" and that they were "especially pleased" with the 16 September 1975 ASD/I&L guideline memo.

CODSIA expressed "serious concern" over one aspect of the ASD/I&L memo that stated -

> It [RIW] can be applied to any new equipment, even if the design utilizes new technology and there is no previous field experience.

and the words -

> . . . firm fixed price bid . . .

They were specifically concerned over the application criteria in the face of the memo's statement and the nature of the testing required to support a firm fixed price offer. They were, however, "impressed with the spirit in which DOD is approaching this complex and relatively untried subject of RIW." In an effort to update the open issues and assist DOD and industry in arriving at a workable RIW concept, CODSIA also provided their own RIW program characteristics in 11 areas for consideration.

In closing their letter, they were "apprehensive that the tempo of RIW use in RFP's is being and will continue to be accelerated." They

urged that the concept be tested "on a more selective and controlled basis" as previously done with other new concepts. CODSIA's key recommendation was that "perhaps at this juncture even a temporary moratorium on additional testing would be desirable." (Underlining added.)

E. Tri-Service Reliability and Support Incentives Group

Since this group has the responsibility to pull together and work out the many facets of the RIW concept and implementation, mention should be made of some of their major continuing objectives (9:A-24).

a) Assessment of the factors that constitute contractor risk. Identification of how these can be reduced below the expected contractor benefits.

b) Assessment of the factors that constitute government risk. Identification of how these can be reduced below the expected government benefits.

c) Provide clarification of the RIW concept and its objectives.

d) Determine what equipment and management factors underlie successful RIW efforts.

e) Continued development and assessment of cost methodologies which will more effectively facilitate proper understanding of the economics associated with RIW applications.

f) Determine the feasibility of applying the RIW concept to modules of electronic equipment and mechanical devices along with any resultant design impact.

g) Consider additional procurement strategies which increase incentives for improved field reliability and lower support costs.

At this point the CODSIA and DOD considerations are still being assessed.

SECTION IV

OPINIONS

The purpose of this section is to present several additional Government and industry comments that can apply to warranties. It is recognized that these remarks were not made at the same point in time and that they might be construed in some cases to be taken out of context. The point is that they do contain feelings generally supporting a type of RIW concept but recognizing proper structuring.

A. Government Comments

> The importance of improving the reliability of our weapon system is virtually self-evident; yet past experience has amply demonstrated how elusive an objective it really is (8:1).
>
> Jacques S. Gansler
> Deputy ASD/I&L (Materiel Acquisition)
>
> ---
>
> There are a lot of people in the system who still believe that we can whiplash the contractor around the way we did in the thirties and forties, who believe they are really serving their government if they squeeze out that last tenth of a percent of profit. There's a tremendous amount of that still in the system and it is simply not appropriate in today's environment and with today's limited availability of contractors who want to do DOD business.
>
> We add 10 or 20% to the cost of each and every one of our contracts on the basis of not taking any personal risk (15:8).
>
> Leonard Sullivan, Jr.
> ASD/PA&E

While the contractor should do his best because it is expected of him, exceptional performance in the improvement of reliability can be counter to a manufacturer's financial interests in terms of reduced spare parts sales. Also, traditional fixed price type contracts, even with performance incentives, can discourage design changes essential to reduced O&S costs (8:22).

Robert F. Trimble
Assistant Administrator for Contract Administration
Office of Federal Procurement Policy

Reliability Improvement Warranties cannot be used as a club; however, they can be useful if both the producer and user are directly involved in the cost reduction process (7:4).

Dr. John J. Bennett
Acting ASD/I&L

B. Industry Comments

There are at least two circumstances that will generate a devoted and responsible effort toward designing for minimum LCC. One would be a requirement for the contractor to provide a long-term, failure-free warranty. . . . (7:30).

William H. Boden
Program Manager, UHF Radios
The Magnavox Company

I do not contend that warranties are a panacea for the military's problems. In fact, one of any major concerns is that the concept might acquire the "buzz word" status, and nothing could be less conducive to a reasonable application of warranties. . . Instead, the concept should continue to receive thorough investigation and appropriate experimentation so we can evaluate its full potential and its range of applicability as a cost management technique (7:28).

C. R. Knight
Vice-President-General Manager
ARINC Research Corporation

From the avionics manufacturer's standpoint, Carl R. Henrici, Collins' program manager on the ARN-118, sees another advantage of RIW. This is to get prompt feedback on the specific causes of field failure, so that corrective action can be taken on current production (18:58).

Aviation Week and Space Technology
8 December 1975

SECTION V

CONCLUSIONS/RECOMMENDATIONS

From the foregoing presentation of RIW's development, the remaining major consideration that presents itself is whether or not it is a viable concept worthy of continued "testing" or full implementation. There are three current opinion factions, namely (a) DOD - more trial tests, (b) CODSIA - a "temporary moratorium" (6:4) and (c) ARINC - implement now where applicable (2:iii). There are many points to evaluate in determining the best or optimum DOD decision. Aside from the obvious considerations as to the cost effectiveness of any type RIW or warranty applied in a particular case, are other broader conceptual implications both on the particular system and/or the DOD acquisition business in general. The following final subsections address conceptual implications and provide a recommendation for DOD's decision process.

A. RIW Implications

(1) Under RIW, great care must be taken in the later phase of the warranty to recognize or counter a contractor's potential lack of motivation to continue to give 100% attention to the quality of repairs. If there should be a lapse of intensity, there will be an unplanned for impact on the organic facility assuming repair responsibility. Standard legal recourse precedents may apply however pursuit of them is often difficult. A long term, secure feeling warranty should not lull us into ignoring potential soft areas.

(2) Some sectors view RIW as a potential encroachment into or eroding of in-service maintenance capabilities. The ultimate case would be that all systems would be contractor maintenance for the life of the systems. This situation, however would never occur. The concerns in this area are well founded if a RIW concept is pursued without considering the families of equipment it is applied to from a mix of complexities, skills, technology or equipment viewpoint as applied to organic maintenance capabilities. When RIW is considered, review should be done of its impact on whatever balance of maintenance capabilities is desired for that type equipment or technology on both depot and organizational levels. Without a controlled use of RIW, it is conceivable that certain organic maintenance categories may be affected. As case-by-case reviews are made, considerations should be give to training requirements and war-time surge (organic or contractor) capabilities.

(3) A policy review may be appropriate in the area of RIW's impact on the Value Engineering (VE) program. Additionally, care should be taken to avoid inclusion of both RIW and VE provisions in a manner that could prove self-defeating.

(4) The contractor's RIW efforts to improve MTBF may inherently have potential overlap with other programs (government or commercial) the contractor is working on. The audit or policing of this situation may be very difficult. If not somehow monitored, "windfall profits" may occur.

(5) RIW may not be easily applied to Foreign Military Sales (FMS) items. In all likelihood separate negotiations and provisions will be required. The total impact of a RIW-FMS situation should be assessed from a DOD and country point of view. Costs may exceed benefits to the country and the

administration of such a contractual relationship may be a great burden to DOD agencies and the contractor. The full story should be presented all parties.

(6) RIW may in some respects be considered a panecea, however, its application is complicated by several factors. Among them are the types of systems, system or item stage of development, "off-the-shelf" items, or "slightly" modified (for military) commercial items. The RIW implication in each of these varies for the government and contractor in terms of risk, incentives, benefits, enforceability potential or contractual provisions. The generalization of the concept and implementation details requires caution.

B. Recommendation

The literature indicates RIW has either proved its merit or has the potential for benefits. This is of course subject to interpretation or debate. Of prime importance to any RIW payoffs would be the proper application and/or implementation in each usage. Achievement or consummation of the assessment of its merit, benefits, hazards and policies is the task that DOD is at grips with now.

The project started in August 1973 with the DOD Trial Use of Warranties in the Acquisition of Electronic Subsystems. In August 1974 the project was further definitized and the term RIW and its concepts were presented for the trial use project. However, no specific trial/test parameters have been established. Currently the individual services may apply RIW as they determined within the overall DOD guidelines.

The test is thus basically unstructured with no set limits for inclusion nor completion phase points. Additionally, the test may be influenced by the inputs of CODSIA and ARINC. DOD should be assured that any coordinations with CODSIA speak for the majority of the actual industries and companies.

Since the ultimate fate or future of RIW should result from an unbiased trial evaluation, it is my contention there should be a structured test of the concept. The Air Force, for example, has a degree of this by requiring Air Staff, AFLC and AFSC joint reviews of proposed RIW candidate plans (24:1), however there is no discernible control for selection of candidates, thus allowing an ever broadening of the test base.

Recently, DOD initiated a major service test of a new four step source selection procedure through DOD Directive 4105.62, 6 January 1976 (26:7). Subsequently, several specific programs were identified to be the test base. Because of the significance of the RIW concept, a similar structuring of the test base along with specific DOD evaluation guidance and milestones would be beneficial. Without such a base, the test evaluations will be complicated by the constant program additions reflecting guidance revisions.

The Assistant Administrator for Contract Administration in the Office of Federal Procurement Policy, Robert F. Trimble, has stated -

> "The RIW concept must not be allowed to become another "buzz word" approach to procurement. DOD procurement has historically over-reacted to new concepts and procedures . . . . If RIW concepts are applied without very careful planning, the likelihood of failure is great." (8:23)

To achieve a proper evaluation, the test phase is crucial. These evaluations should, however, be done as expediously as possible in order to formally initiate the concept (or portions of it) to avoid a constant series

of discussions, revisions, new ideas, etc. People will always be striving for perfection, but in doing so will sometimes never build the first item. This is not to be interpreted that adequate testing should be sacrificed, however, an early baseline is important since major aspects of the concept have been under review since the mid 1960s FFW introduction.

Alternatives to the current DOD test approach are (a) formalize the test, (b) implement the concept based on existing data, or (c) terminate the test. It is my recommendation that (a) the test be formalized for a period of one more year or less; (b) the current RIW programs be evaluated in depth and new programs be added very selectively (if at all); (c) DOD, CODSIA and ARNIC coordinate or compromise on implementation details and contractual provisions based on the findings of the one year test (if RIW is approved as a concept for continued use).

The substantial agreement between DOD, CODSIA and ARINC on policies and procedures will be a key factor in any future use of effectiveness of a RIW concept.

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